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(54) ELECTRIC FOOD-HEATING APPLIANCE

(71) We, YVES TRICAULT, of 23, Boulevard Montmorency, Paris, France, and GERARD TRICAULT, of 90, Avenue André Morizet, Boulogne-Billancourt, France, both of French Nationality,

do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a household appliance intended for heating ready-cooked foods or deep-frozen foods in particular.

Heating appliances have become particularly convenient owing to the considerable development of the ready-cooked food industry, provided they fulfil certain conditions; otherwise the gustatory properties of these foods will be affected in a highly undesirable manner. Indeed, the "heated-up" taste is well-known, which food takes when the operation is carried out in an elementary manner, for example when it is thought sufficient to pour the ready cooked dish into a pot which is heated on a gas-cooker.

In the British Patent No. 1,057,216 there is described an appliance for heating ready-cooked foods in quantity. This appliance offers a number of slight inconveniences which, without being of much importance in normal use, could be troublesome for household use. The appliance is in the shape of a doorless heating cupboard, thermally insulated, inside which are fitted numerous stacked heating elements, composed of electrical resistances between which are placed a set of shelves carrying the food to be heated. This set of shelves is displaceable and is carried on a trolley. It is placed in front of the heating cupboard and forms the door to the latter.

It is clear that, to ensure smooth entry and exit of the ready cooked food into and from the cupboard, it is necessary to arrange for a certain space between the heating resistances, if only to let through the shelving grids themselves. On the other hand, for manufacturing and ease of maintenance reasons, it is preferable not to arrange the heating resistances along the inner vertical walls of the cupboard. This results in the outer wall of the food container enclosing the food receiving thermal radiation from both the sources of heat and the non-heating sections of the cupboard and reflecting radiation issuing from these sources towards the colder parts of the arrangement.

This also means that a part of the electric power received by the containers containing the foodstuff serves solely to heat the cupboard. The system does not constitute a closed heat circuit; it receives radiation from the sources which it transfers to the cupboard. Therefore a considerable part of the spent energy is wasted. This inconvenience may be considered as a minor one for appliances intended for communities, useless expenditure on electricity being, in any case, practically negligible compared with the considerable costs of operating a works restaurant or a hospital kitchen.

The case is not the same for household appliances. When calculating the cost price, the utilizer is ready to neglect the time spent for a given operation, and he is highly sensitive to any expenditure of cash to be made by himself, and an economy in this respect, even a relatively small one, will be taken into consideration.

In an appliance according to a preferred embodiment of the invention, the number of food containers to be heated is not large, for example between one and four. It is therefore not necessary to arrange the food containers one above the other, and it is perfectly reasonable to place them one beside the other. This arrangement is highly advantageous since the lost power is reduced to a negligible minimum.

Moreover, in the formerly known appliances, the radiation reflected by the external surface of the food containers depend on the optional qualities of this surface. As the heat system is not a closed one the heating of the said external surface will also depend on its optical quality, its state of polish, its stains, scratches etc. . . . The effect is no doubt not very

important, since part of the radiation reflected by the containers heats other containers contained in the cupboard. However, it does exist and may explain certain slight irregularities in the heating of dishes, generally speaking not very troublesome ones when the equipment is well maintained.

The latter drawback is entirely eliminated in an appliance according to a preferred embodiment of the invention. In the latter, the inside of the heating appliance which, optically speaking, is the same as that of the containers, forms a black body in which the physical condition of the wall plays no part and where the time required for reaching the desired temperature level no longer depends on the above-mentioned surface condition.

According to the present invention, there is provided a food heating appliance comprising a base and a lid, the base being shaped to receive at least one food container to be heated, said base containing refractory material in which is embedded a base heating electrical element, said base being bounded by two metal plates, the lid serving to fit over said base and food container, the lid containing a heat insulating material with a lid heating electrical element embedded therein, the lid being bounded by an upper and a lower metal plate, said lower lid plate being polished and reflective.

Preferably, the ratio of the resistances of the two heating elements is such that when connected as intended to an electrical supply, the heat produced by the base heating element is between two and four times the heat produced by the lid heating element.

An embodiment of the invention will now be described in detail by way of example and with reference to the accompanying drawings, in which:—

Figure 1 is a transverse section view of a heating apparatus in accordance with the invention and designed for heating one food container;

Figure 2 is a perspective view of the lid of the appliance of Figure 1;

Figure 3 is a perspective view of a heating appliance in accordance with the invention and designed for heating four food containers;

Figure 4 is a perspective view of the lid of the appliance of Figure 3; and

Figure 5 is a diagram for explaining the functioning of the appliance according to the invention.

When food to be heated and contained in a food container plate is placed in an appliance described hereinafter, its upper part is mainly heated by radiation and its lower part mainly heated by condition.

The law of heat transmission by conduction, assuming the respective temperatures T_s and T' of the heat source and of the heat-receiving body to be constant, is expressed by:

$$(1) \qquad Q' = \frac{cS}{\delta}(T_s - T')t$$

where Q' is the quantity of heat supplied by the base heating resistance during the time t, c the heat conductivity of the material forming the base, S its surface and δ the thickness of the material traversed by the heat, T_s the absolute temperature of the base heating resistance and T' the absolute temperature of the heating plate. The value T'_o of T' at the initial moment t=o varies, according as to whether the food is a deep frozen one or a food at ambient temperature, from 265°K to 300°K. If C designates the calorific capacity of the appliance's base heating plate, one has the differential relationship:

$$(2) \qquad dQ' = CdT'$$

By combining the equation (1) now written in differential form with respect to time, that is

$$dQ' = \frac{cS}{\delta}(T_s - T')\,dt$$

(T' being no longer constant), it is found that:

$$(3) \qquad (T_s - T') = (T_s - T'_o)\exp(-cSt/C\delta) = (T_s - T'_o)\exp(-t/\theta)$$

with $1/\theta$ equal to $(cS/C\delta)$.

The curve giving T' as a function of t is the curve A in Fig. 5.

The power radiated by the lid is proportional to the difference between the fourth powers of the absolute temperature of the inner side of the lid T_c^4 and the absolute temperature of the upper part of the food to be heated T''^4. The temperature T'' varies from an initial value T_o'' which is the same as that T_o' of T', that is to say between 265°K and 300°K, to the final heating temperature, let us say 350°K. In the whole variation range of T'', T''^4 can be neglected as compared to T_c^4 which, as will be seen, is in the range of 450°K.

This means that the power Q'' issuing from the dish-cover radiating towards the dish is basically constant (at most very slightly decreasing) as a function of time and that T'' is then a linearly increasing function of time t (curve B in Fig. 5).

It may be assumed, for instance, that the insulated base heating resistance be at a temperature T_s of 90°C, the initial temperature T_o' be at most 15°C, and the final temperature of the heating plate be limited to 75°C, in order to avoid any burning of the food, this corresponding to a fall of $(T_s - T')$ of

100% to 20% thus to a variation of t equal to 1.6 θ.

Then, referring to Fig. 5, the ordinates of points O and M respectively corresponding to the values 100% and 20% of the quantity $(T_e-T')/(T_e-T'_o)$ while the difference in their abscissas is 1,6 θ. The slope of curve A at point O, which is proportionate to Q′, is $1/\theta$. The slope of curve B which is proportionate to Q″ is

$$\frac{(100\%-20\%)}{1{,}6\ \theta}=1/2\ \theta.$$

The result is that the value of Q′ should be twice that of Q″, and thus that the value of the base heating resistance should be twice that of the lid heating resistance.

In the preceding explanations, it has not been possible to take into account losses of heat by radiation from the base. These losses lead to an increase in the ratio Q′/Q″ from 2 to 4. In point of fact, the experiments of the present applicants have shown that good results are obtained when the ratio Q′/Q″ is between 2 and 4.

It is very important to observe that the upper part of the food is always at a higher temperature than the lower part and that for this reason the lid is always at a higher temperature than the rest of the appliance housing. Consequently, there is no possibility of steam condensation, and a favorable condition for heating ready-cooked food without modifying its taste is thus fulfilled.

It should also be remarked that the fulfilling of the latter condition is independent of the value of the factor $(cS/C\delta)$.

Referring now to Figs. 1 and 2, a hollow base formed of two aluminum plates 2 and 3 is shown, forming a housing containing refractory material 4 such as sand or gravel. The heat conductivity of the base material is of the order of 1 kilocal/(meter × hour × degree). Inside this material 4 an insulated heating resistance 5 is embedded, which in order to heat the base in homogeneous manner, is in the form of a spiral if the base is round, or in that of a sinusoidal curve with its axis parallel to one of the sides of the base, if the latter is square.

The floor 2 of the hollow base is dished and is shaped to fit exactly a food container 6 provided to receive food to be heated. The container 6 is made of porcelain or similar materials, as usual.

The base is, in use, covered with a lid 7 composed of an inner envelope 8 consisting of a polished stainless steel plate, an outer envelope 9 made of aluminum sheet and a heat insulating filler material 10, for instance a piece of asbestos or glass wool. The heat conductivity of the lid material is in the range of 0.2 to 0.3 kcal/(m × hour × degree). An insulated heating resistance 11 is embedded in the latter heat insulating material with an arrangement similar to that of resistance 5 in material 4.

The lid 7 is provided with a handle 12 containing the power supply lead 13 and a timing mechanism 14 (shown in Figure 2).

Resistances 5 and 11 are connected in series by means of pins 15 fitted into the base and corresponding sockets 16 fitted in the lid. In this manner the current is automatically cut off when the lid is not secured to the base.

Figures 3 and 4 represent an appliance designed for heating four plates. The base 17 is divided into 4 bowls 18_1 to 18_4, separated from each other by partitions 19_1, 19_2. These partitions are hollow and contain refractory materials, like the bottom of the base. The heating resistance is arranged in sinusoidal form throughout the whole surface of the base.

The lid is divided into four smaller lids by partitions 21_1 and 21_2 which, when the lid is its normal position over the base, are superimposed and jointed with the partitions 19_1 and 19_2. These partitions are hollow and contain heat resisting material like the inside of the lid. The metal sheets forming the inner wall of these smaller lids are made of polished stainless steel.

The value of the base resistance is between four times and twice that of the lid resistance, for the reasons which have been explained above.

WHAT WE CLAIM IS:—

1. A food heating appliance comprising a base and a lid, the base being shaped to receive at least one food container to be heated, said base containing refractory material in which is embedded a base heating electrical element, said base being bounded by two metal plates, the lid serving to fit over said base and food container, the lid containing a heat insulating material with a lid heating electrical element embedded therein, the lid being bounded by an upper and a lower metal plate, said lower lid plate being polished and reflective.

2. A food heating appliance according to claim 1 in which the ratio of the resistances of the two heating elements is such that when connected as intended to an electrical supply, the heat produced by the base heating element is between two and four times the heat produced by the lid heating element.

3. A food heating appliance according to claim 1, wherein said base and lid contain means for connecting said base heating element and said lid heating element in series, and wherein said base heating element has a resistance value of between two and four times that of said lid heating element.

4. A food heating appliance according to any one of the preceding claims, wherein said refractory material consists of sand.

5. A food heating appliance according to any one of claims 1 to 3 wherein said refractory material consists of gravel.

6. A food heating appliance according to any one of the preceding claims, wherein said two metal plates of the base are made of aluminium sheet.

7. A food heating appliance according to any one of the preceding claims, wherein said lower plate of the lid is made of polished stainless steel.

8. A food heating appliance according to any one of the preceding claims, wherein said heat-insulating material is asbestos.

9. A food heating appliance according to any one of claims 1 to 7, wherein said heat-insulating material is glass wool.

10. A food heating appliance according to any one of the preceding claims, wherein the base is provided with one or more recesses each of which is adapted to receive a food container, the appliance including one or more said food containers, the base of the or each food container being shaped to fit exactly within a corresponding recess.

11. A food heating appliance substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

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1,328,755 COMPLETE SPECIFICATION

3 SHEETS

This drawing is a reproduction of the Original on a reduced scale.

SHEET 1

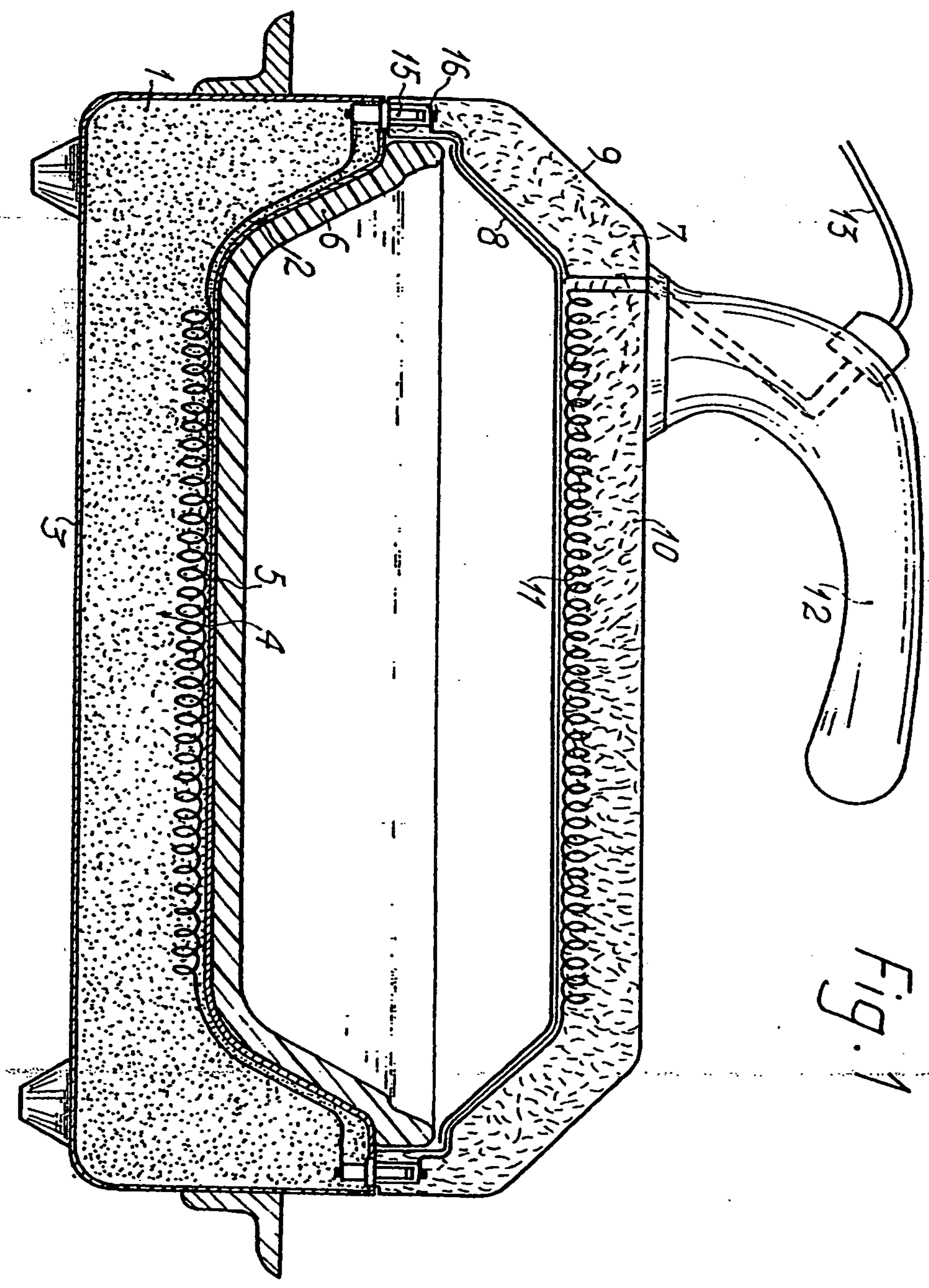

Fig. 1

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Fig. 2

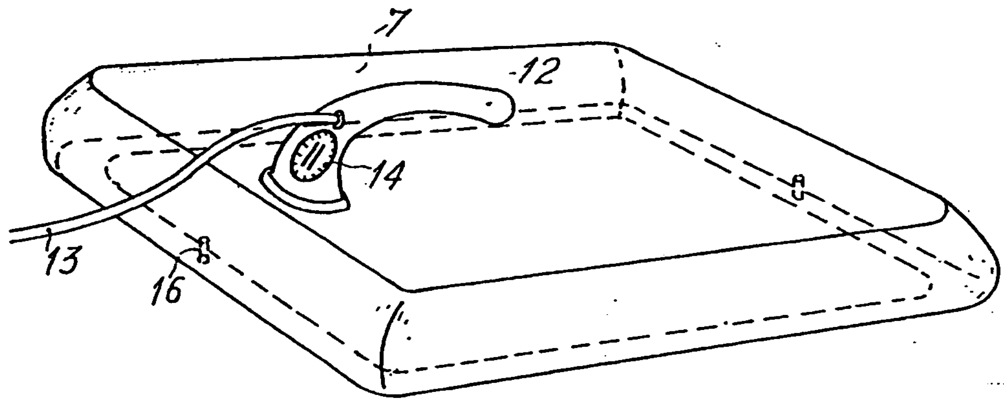


Fig. 5

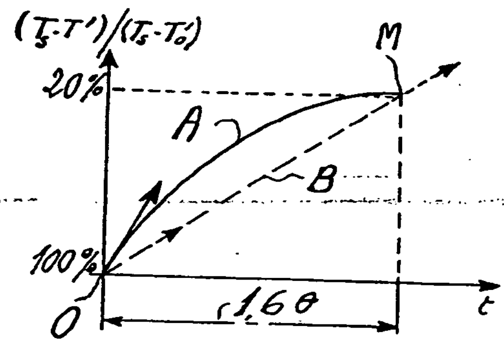
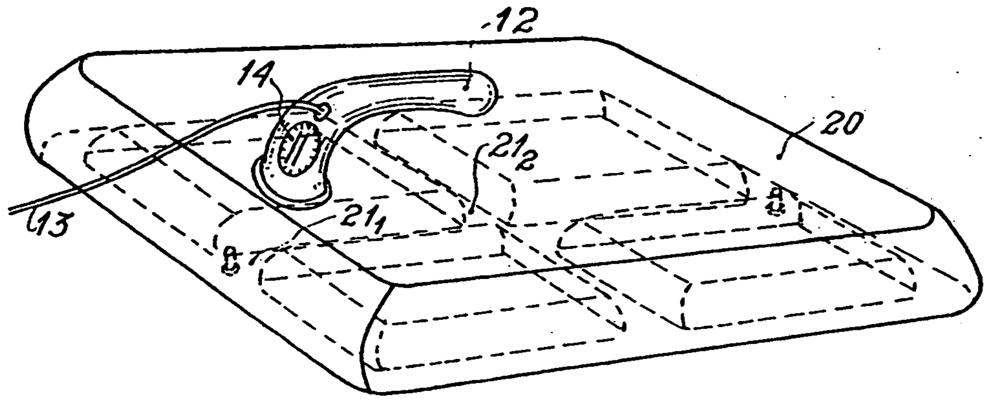


Fig. 4



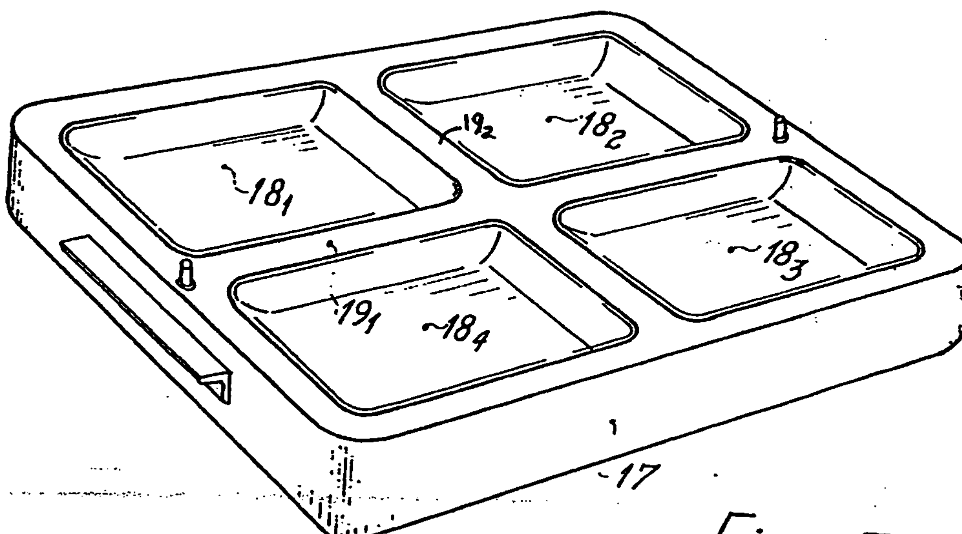


Fig. 3

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